Preliminary results on Epidemiology of Coconut Lethal Yellowing in Ghana

François Bonnot (1), Gilbert Danyo(2), René Philippe(1), Sylvester Dery (2) and Arthur Randsford (3)

(1) CIRAD, (2) OPRI, (3) CSDP

Context of the research program on epidemiology of Coconut Lethal Yellowing in Ghana

Epidemiological studies are of major importance in understanding the determinants of plant diseases in order to control the risks of their spreading

Few observations made in the past on epidemiology of Coconut Lethal Yellowing in Ghana (= Cape Saint Paul Wilt Disease or CSPWD)

Regional level : observation on farmer plots between 1993 and 2000

Plot level : 4 plots of 150 to 400 palms monitored monthly in central Region (1992-1994)

Major problem : lack of quantitative data

Some references

NRI (1993). Etiology and control of lethal yellowing-type deseases of coconut palm in Africa STD III Contract. Annual report for 1993.
R. Philippe (1995). Etudes sur les insectes vecteurs de la maladie à mycoplasme du Cocotier au Ghana
R. Philippe (November 1996). Etudes sur les insectes vecteurs et sur l'épidémiologie de la maladie à mycoplasme du Cocotier au Ghana
R. Philippe (May 1997). Studies on vector insects and the epidemiology of the Coconut phytoplasm desease in Ghana
R. Philippe, S.K. Dery (2000). Coconut sector development project - Crop protection mission of the project 05/10 to 23/10/2000

New program on epidemiology of CSPWD in Ghana

Program launched in march 2007 in cooperation between OPRI, CSDP and CIRAD (1)

General objective: integrated knowledge of CSPWD and environmental variables

Main issues:

- distribution and spread of CSPWD in space and time
- relation of CSPWD with the environment
- determinants of CSPWD in Ghana
- quantitative parameters of CSPWD (rate of spread, probability of transmission...)
- recommendations for new plantations (sites, varieties, field management...)

Work plan

Survey on farmer plots	Precise monitoring of a few sampled plots	Observation of disease spread in a zone planted with local tall palms	Use of remote sensing

(1) **F. Bonnot.** Epidemiology of Coconut Lethal Yellowing in Ghana. Report on the mission from 20 February to 2 March 2007

Survey in CSDP plots

Existing plots

Western Region and Central Region
1166 plots
1 or 2 hectares / plot
1300 hectares
1012 farmers
Planting 1999 – 2004
Material: MYD x VTT hybrids

Expected outputs of the survey

- Maps of disease incidence and outside variables
- Relation between disease incidence and outside variables

Categories of variables

Geographical coordinates (GPS)

Outside variables
Hydrography
Topography
Soil
Agronomical and ecological data inside the plot
Agronomical and disease situation around the plot

Phytosanitary data
Number of palms
- Planted
- Alive
- Diseased
- Dead

(several dates)

Outside variables

PLOT IDENTITY
- Region
- District
- Village
- Farmer
- Farm size
- Year Planting

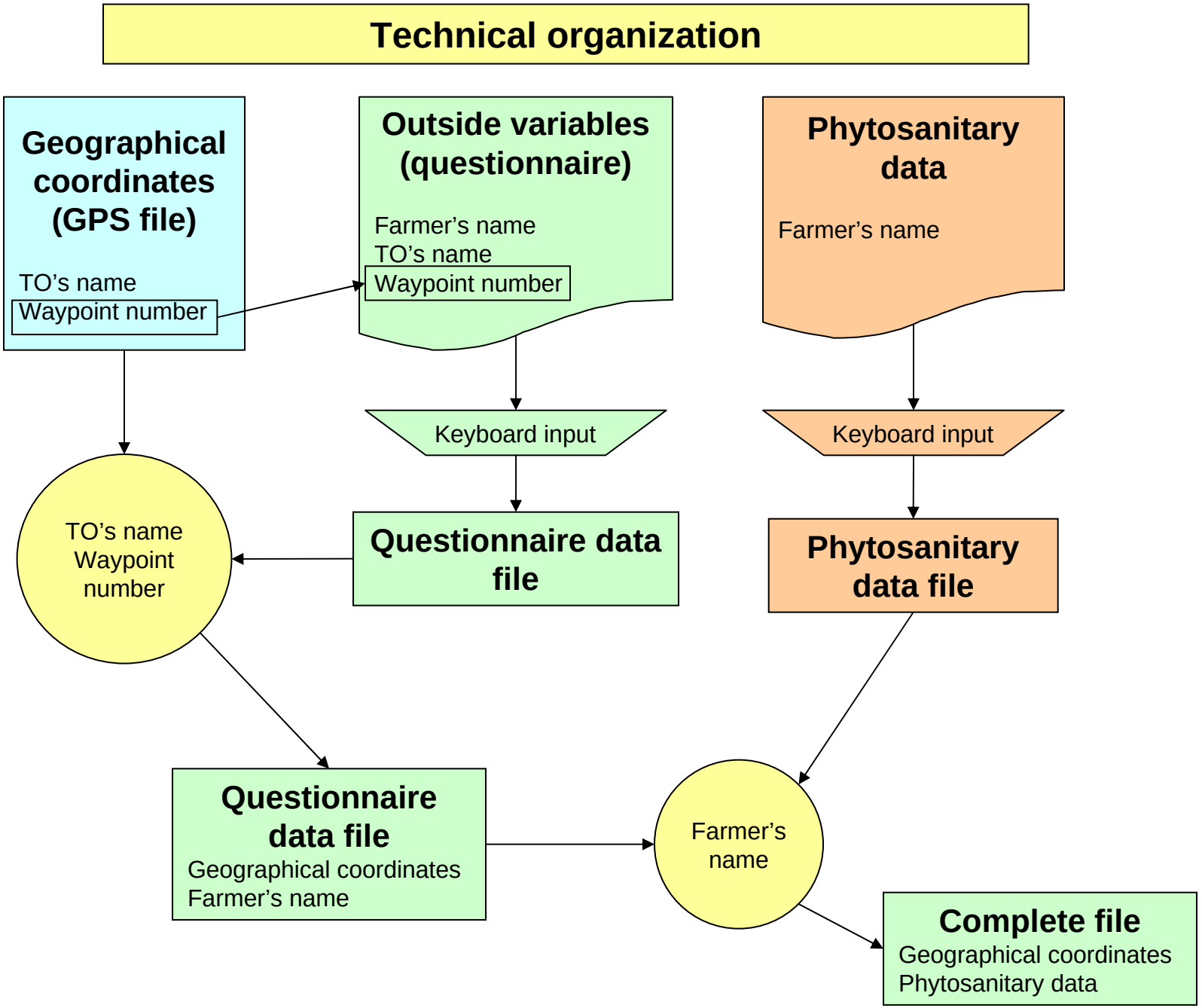
TOPOGRAPHY
- **Location** (On the top of a hill, Along a slope, At the bottom of a slope, In the bottom of a valley)
- **Slope** (Low, Medium, Steep, Flat)

SOIL
- **Color of top soil** (Black, Dark red, Dark brown, Dark grey, Light red, Light brown, Light grey)
- **Soil texture** (Light, Heavy)
- **Coarse elements** (Absence, Few, Many)

HYDROGRAPHY
- **Presence of water** (A river or a stream, A swampy area)
- **Distance from the plot** (Less than 10 m, 10 m to 50 m, More than 50 m)
- **Is the plot floodable ?** (Never, Between 1 week and 1 month a year, Less than 1 week a year, More than 1 month a year)

AGRONOMICAL AND ECOLOGICAL DATA
- **Previous land occupation** (Coconuts, Forest, Others to precise)
- If coconuts, year when the lethal yellowing killed the old coconuts
- **Current Maintenance** (Absence, Poor (bushy but accessible), Good (easily accessible), Very good (no weed, no bush)
- **Use of herbicide** (Yes or no)
- If Yes, Frequency (Once, Twice, Thrice a year)
- **History of the plot after coconut planting** (years 1 to 9) (Pueraria, Chromolaena, Grasses, Shrubs, Cassava, Citrus, Plantain, Pepper, Tomato, Eggplant, Pineapple, Maize, Oil palm, Rubber, Cocoa, Sugar Cane, Other)
- **Fertilizer application** (Yes or no)
- If yes : frequency (1st yr, 2nd yr, 3rd yr, After 3 yrs)

AGRONOMICAL AND DISEASE SITUATION AROUND THE PLOT
- **Land occupation around the plot** (less than 1 km) (Forest, Bush, Citrus, Plantain, Cassava, Pineapple, Tomato, Eggplant, Pepper, Sugarcane, Maize, Oilpalm, Rubber, Cocoa, Other)
- **Is there lethal yellowing around the plot** (No, at less than 500 m, between 500 m and 2500 m, between 2500 m and 5000 m)


Technical organization
Geographical coordinates (GPS file)
TO's name
Waypoint number
Outside variables (questionnaire)
Farmer's name
TO's name
Waypoint number
Phytosanitary data
Farmer's name
Keyboard input
Keyboard input
TO's name Waypoint number
Questionnaire data file
Phytosanitary data file
Questionnaire data file
Geographical coordinates
Farmer's name
Farmer's name
Complete file
Geographical coordinates
Phytosanitary data

Data available

895 questionnaires
329 in Central Region
566 in Western Region

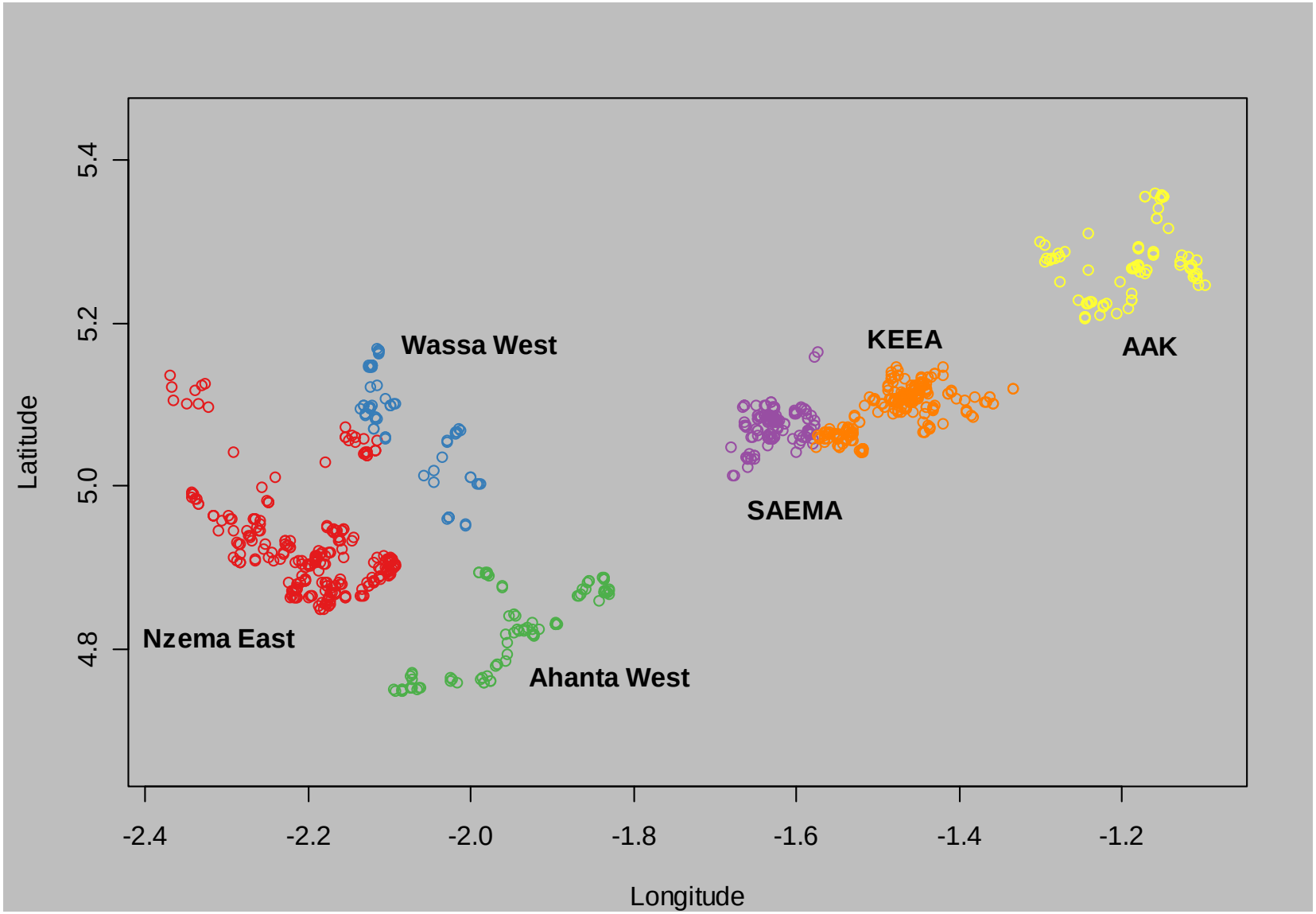
District
Nzema East : 273
Wassa West : 68
Ahanta West: 88
SAEMA : 137
KEEA : 237
AAK : 92

Problems

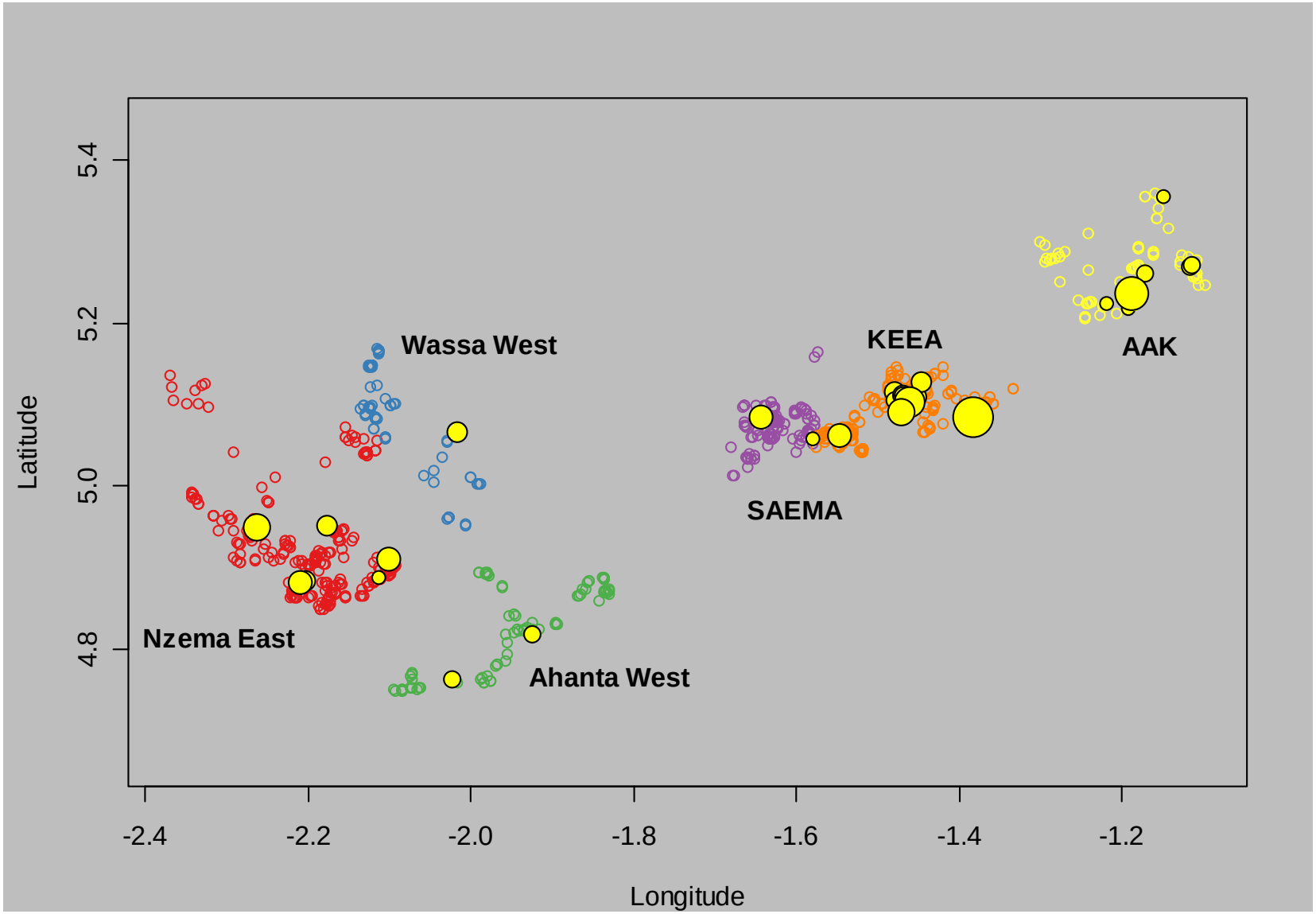
- Phytosanitary data recorded only at farmer level, not at plot level
- GPS coordinates not available for every plot
- Quality of data
- Correspondence between files (GPS, questionnaire, phytosanitary)

- 881 questionnaires with identified GPS coordinates
- 597 questionnaires with identified phytosanitary data
- **590** questionnaires with both GPS cooordinates and phytosanitary data
- 36 plots with lethal yellowing
- **30** plots with lethal yellowing and GPS coordinates

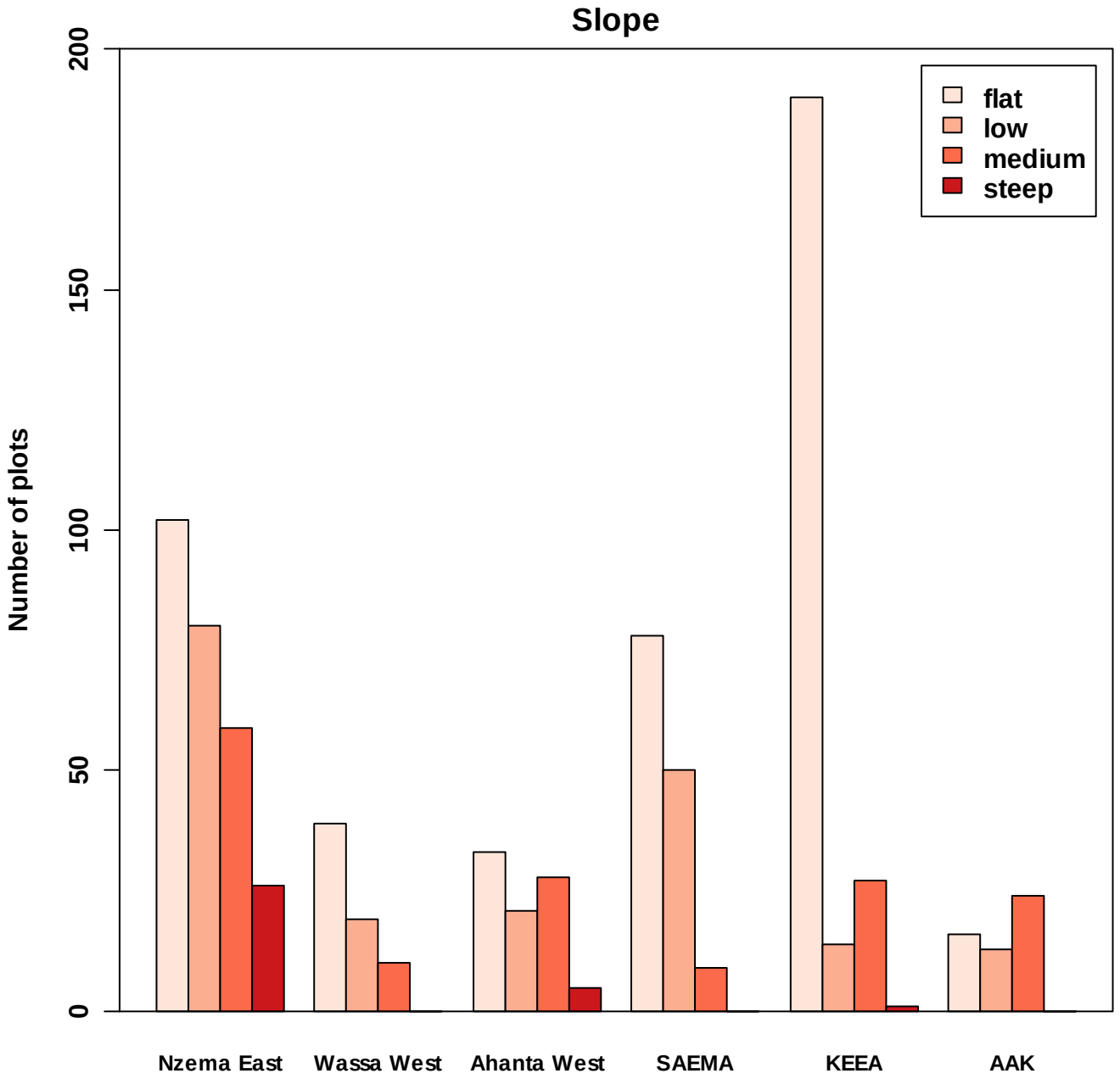
Geographical location of plots (881)



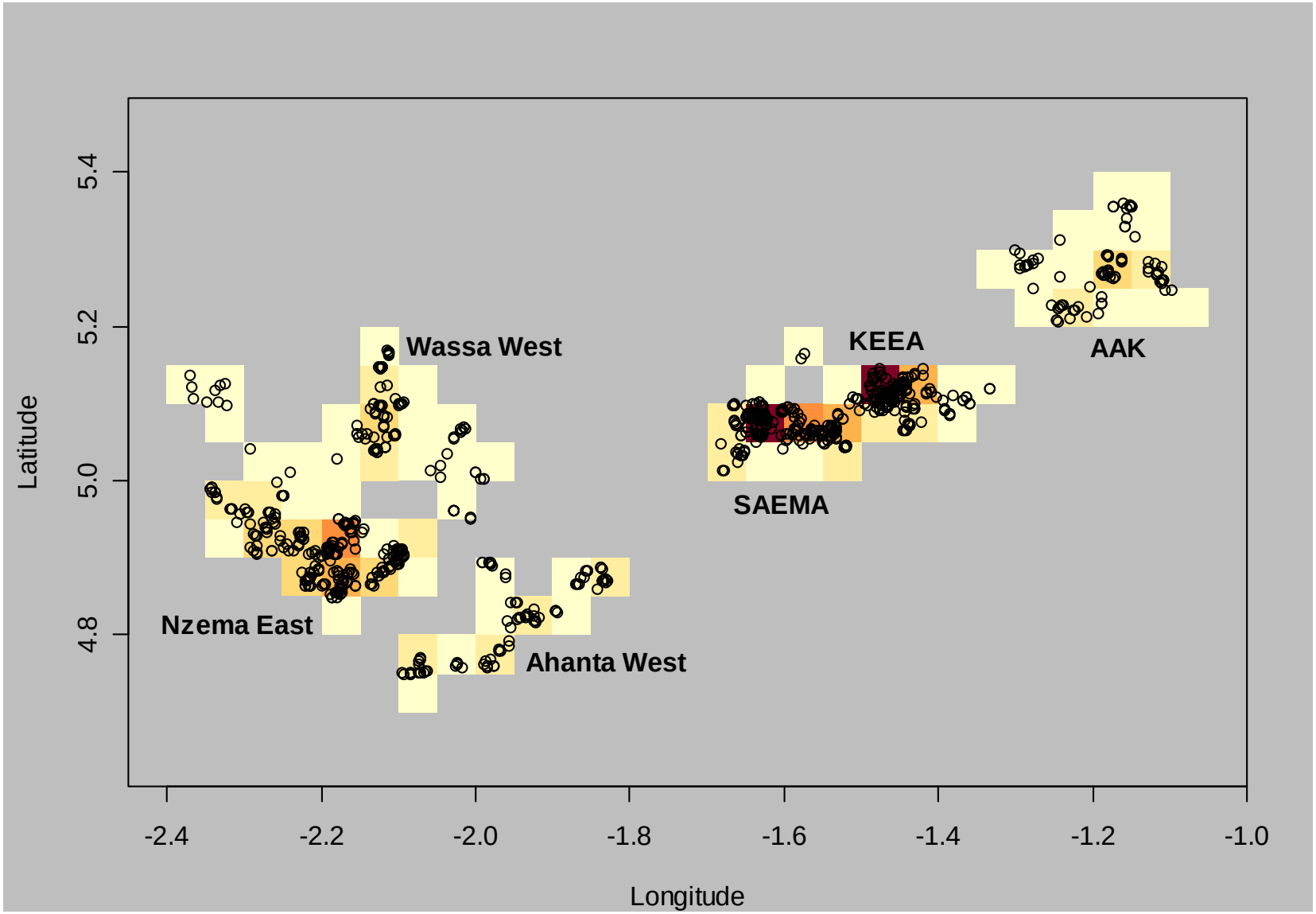
Location of plots (881) and diseased plots (30)



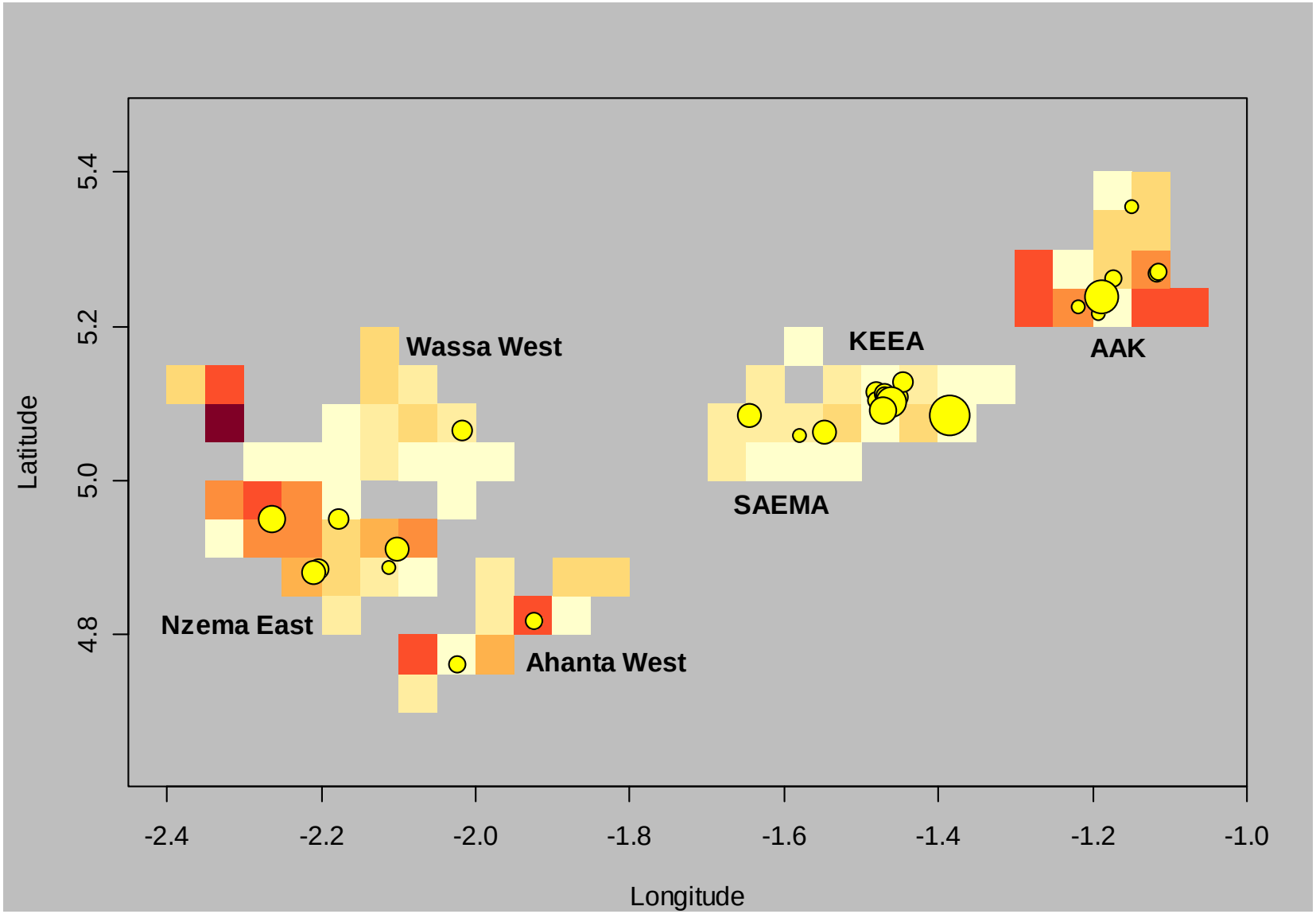
Topography


Slope
Number of plots
0
50
100
150
200
flat
low
medium
steep
Nzema East
Wassa West
Ahanta West
SAEMA
KEEA
AAK

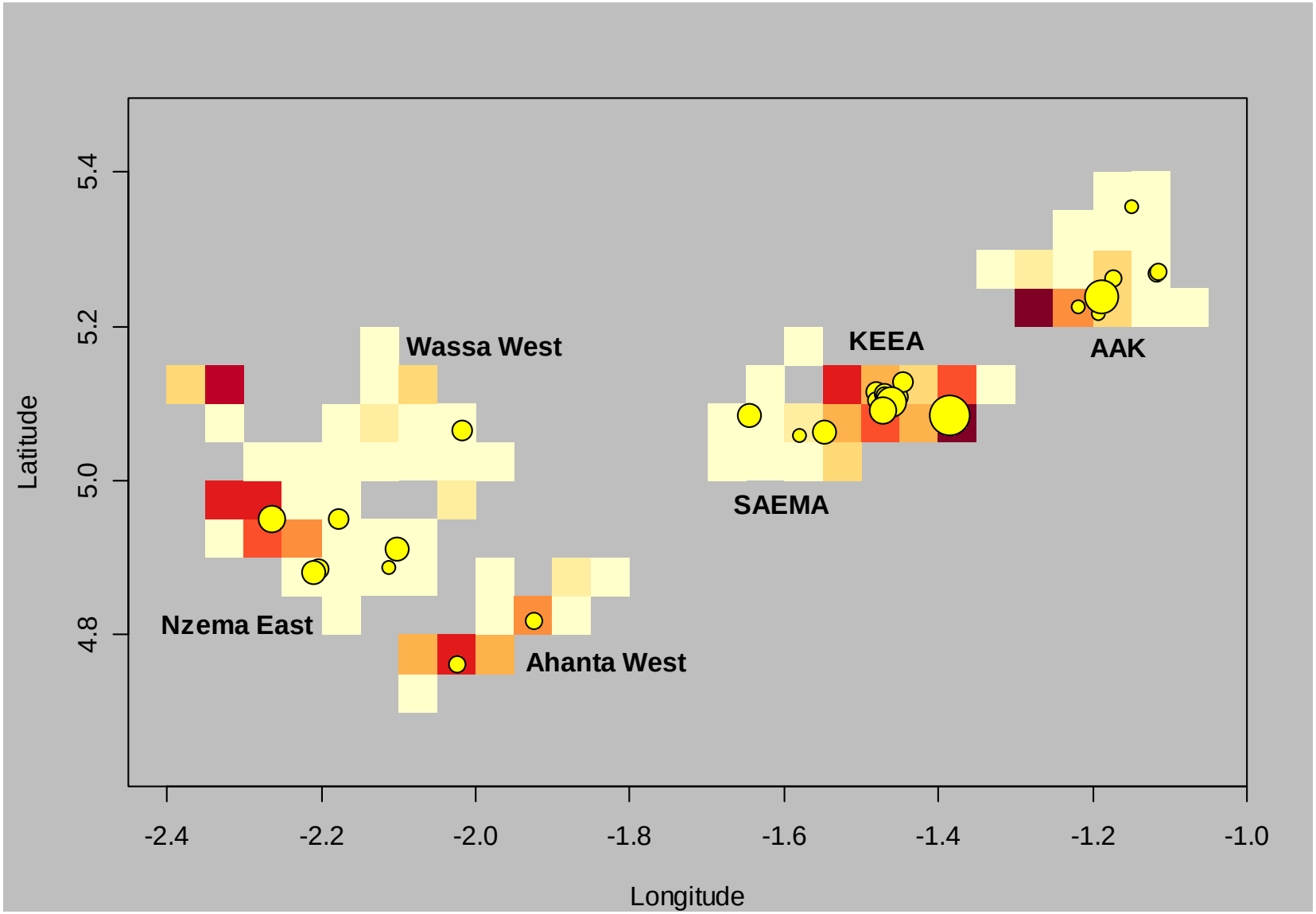
Grouping plots by quadrat



Slope


Wassa West
KEEA
AAK
SAEMA
Nzema East
Ahanta West
Latitude
5.4
5.2
5.0
4.8
-2.4
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
Longitude

Soil texture

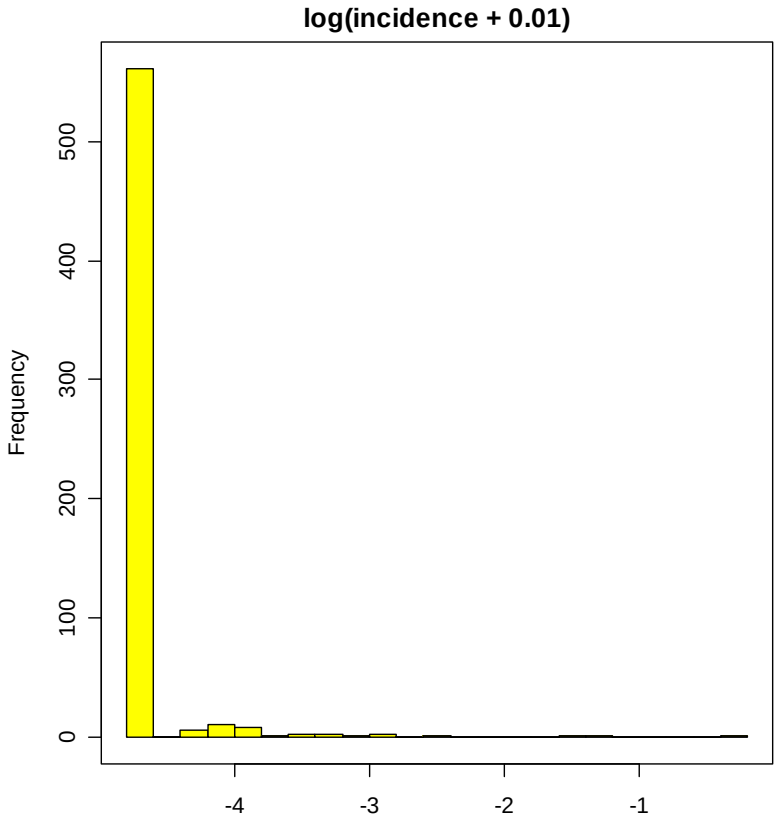


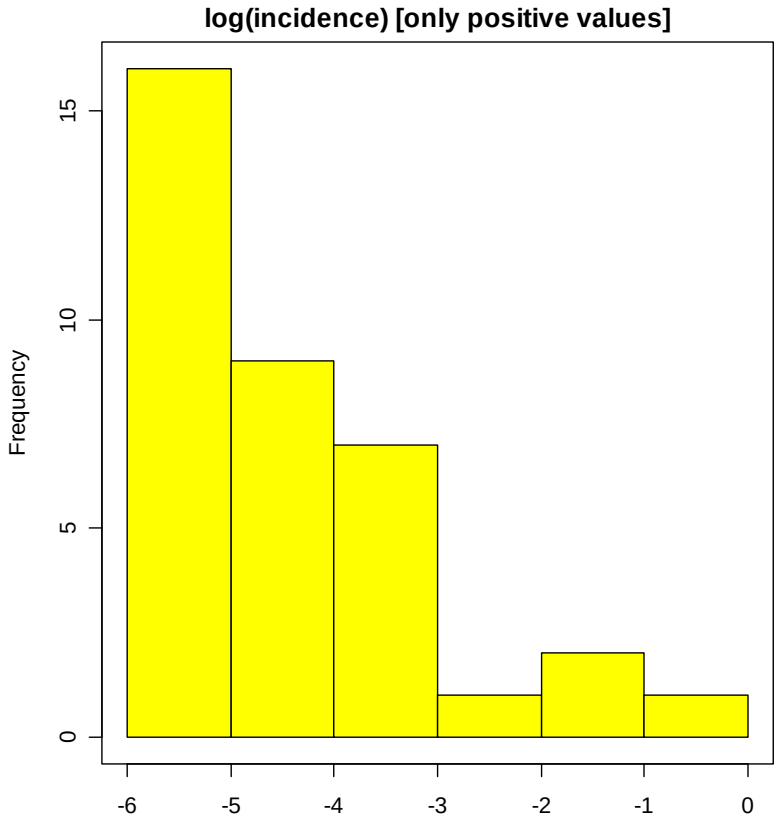
Distribution of incidence of CSPW

Several definitions of incidence per plot:

1. Diseased trees / Planted trees
2. Diseased trees / Alive trees
3. 0 if no diseased tree in the plot, 1 if at least one diseased tree

Data are very overdispersed ("zero-inflated" distribution)





Statistical analyses performed

Incidence per plot used
I = Diseased trees / Planted trees

Statistical analysis method
Logistic regression with estimation of overdispersion parameter
Factors were introduced separately in the model

Significant results (pvalue<0.05)

	slope	incidence
1	flat	0.00787
2	low	0.00061
3	medium	0.00025
4	steep	0.00000

	planting	incidence
1	1999	0.00171
2	2000	0.00130
3	2001	0.01222
4	2002	0.00081
5	2003	0.00222
6	2004	0.00020

	soil texture	incidence
1	heavy	0.00727
2	light	0.00128

	maintenance	incidence
1	absence	0.00015
2	poor(bushy but accessible)	0.00069
3	good (easily accessible)	0.00694
4	very good (no weeds, no bush)	0.00485

	soil color	incidence
1	black	0.01529
2	dark brown	0.00849
3	dark grey	0.00225
4	dark red	0.00024
5	light brown	0.00061
6	light grey	0.00083
7	light red	0.00000

	chromolaena	incidence
1	absence	0.00604
2	presence	0.00067

	cassava	incidence
1	absence	0.00992
2	presence	0.00109

Discussion

- results are only preliminary (incomplete data)
- all the significant effects found should be confirmed and interpreted in term of agronomical factors
- need of adapted statistical analysis methods for overdispersed data
- difficulty to separate the effects of outside variables because of their correlation (confounded factors)
- problems of test validity because of low incidence (low count of infected plots)
- possible more significant effects with complete data
- problems of convergence of algorithms used to estimate overdispersion
- need to take into account the (possible) spatial autocorrelation of the disease